METHOD AND APPARATUS TO ENSURE PROPER GEOCODING

CROSS REFERENCES TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR

DEVELOPMENT

Not Applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not Applicable

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a method and apparatus to ensure proper geocoding in

an asset tracking system. More particular, the invention relates to obtaining multiple descriptors

about a location and preventing the geocoding of the location if the two or more pieces of

information are not spatially near.

DESCRIPTION OF THE RELATED ART

[0002] The prior art relates to asset tracking systems. An asset tracking system helps

organizations manage their assets and how those assets respond to emergencies or incidents.

These systems include the automatic vehicle location (AVL) systems used by city police and fire

departments. In such systems, an agency's asset tracking system controls or directs a fleet of

vehicles. Directing the vehicles begins when a customer calls for assistance. Customers may

range from a buyer of an appliance requesting a service call to a citizen of a town calling the fire

department for help. The organization gathers the customer's address. This data is entered into

the asset tracking system. Once input, the asset tracking system matches a location, using a

longitude and latitude, to the address. The asset tracking system obtains the position for the assets in the asset tracking system. The longitude and latitude is sent to the fleet assets and those assets respond to the location. An agency can compare the location provided by the customer to the positions of the assets, and the asset tracking system can direct an asset near the customer to proceed to the customer's location.

[0003] Unfortunately, this simple and effective system can encounter problems. One problem occurs when the address given by the customer describes two different locations. For instance, many cities have more than one street with the same name. As an example, a city can have more than one "Main Street" or "First Street." Another problem occurs when the asset tracking system cannot find the location of the address. Many growing cities do not have recently created addresses in the asset tracking system. Any of these and more situations cause the asset tracking system to provide responders with erroneous locations and directions.

[0004] Asset tracking systems depend on accurate information to effectively manage the fleet of vehicles. If the information provided by the customer leads to one of the problems mentioned above, the system can sometimes send an asset that is too far away. The extra distance that the asset must cover creates delays in response time. In some circumstances, the asset tracking system sends multiple assets to the location, which creates inefficiencies. In a worst case scenario, sending too many vehicles to one incident may preclude a response to another incident because no resources would be available. An asset tracking system could also send the assets to the wrong location, which would result in no response to a customer's call.

[0005] Thus, there is a need to verify the information given by a customer before allowing the location to be presented to responders.

BRIEF SUMMARY OF THE INVENTION

[0006]   The present invention provides a method for verifying customer locations before using

those locations in the asset tracking system. More specifically, the enhanced asset tracking

system can accept multiple descriptors of the location. The asset tracking system can check that

these descriptors are identifying the same location. If descriptors do identify a same locations,

then the operator can allow the location information to pass to the assets. It will become

apparent in the following detailed description, figures, and claims that these and other problems

are solved by the present invention.

BREIF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0007]   **FIG. 1** shows an embodiment of an asset tracking system used in the present invention.

[0008]   **FIG. 2** shows an embodiment of a mobile device used in the present invention.

[0009]   **FIG. 3** shows an embodiment of an asset server used in the present invention.

[0010]   **FIG. 4A** shows one method in accordance with the present invention of ensuring proper

geocoding for locations allowed in the asset tracking system.

[0011]   **FIG. 4B** shows another method in accordance with the present invention of ensuring

proper geocoding for locations allowed in the asset tracking system.

[0012]   **FIG. 4C** shows another method in accordance with the present invention of ensuring

proper geocoding for locations allowed in the asset tracking system.

[0013]   **FIG. 5** shows one embodiment in accordance with the present invention of an input

screen for the asset tracking system to gather identifiers for the given location.

[0014]   **FIG. 6** shows one embodiment in accordance with the present invention of a GIS map

used to determine if the identifiers target the same location.

[0015]   To clarify, each drawing includes reference numerals. These reference numerals

follow a common nomenclature. The reference numeral will have three digits. The first digit

represents the drawing number where the reference numeral was first used. For example, a reference numeral used first in drawing one will have a numeral like 1XX, while a numeral first used in drawing four will have a numeral like 4XX. The second two numbers represent a specific item within a drawing. One item in **FIG. 1** may be **101** while another item may be **102**. Like reference numerals used in later drawing represent the same item. For example, reference numeral **102** in **FIG. 3** is the same item as shown in **FIG. 1**.

DETAILED DESCRIPTION OF THE INVENTION

[0016]   The present invention will be described in reference to one embodiment of an asset tracking system. However, the invention is not meant to be limited to that one embodiment. There are other embodiments or systems that may require accurate geocoding. Therefore, this invention applies to those other embodiments and systems.

Asset Tracking System

[0017]   **FIG. 1** shows one embodiment of an asset tracking system **100**. This embodiment may include, but is not limited to, several assets **102**, one or more communication networks **104**, one or more internet connections **114**, an asset server **116**, and one or more operators **122**.

[0018]   The assets **102** in the asset tracking system **100** may include several different things. In the embodiment shown, the assets **102** are vehicles. In this embodiment, the asset tracking system **100** may be an automatic vehicle location (AVL) system. An example of an asset tracking system **100** where the assets **102** are vehicles is the typical system used by city fire or police agencies. In these systems, the assets **102** are the fire trucks or police cars. These vehicles are tracked and directed throughout the city to respond to public safety emergencies. Although **FIG. 1** shows the assets **102** as vehicles, the present invention is not limited to that embodiment.

[0019]   In other embodiments, the assets 102 may be people. For example, the asset tracking system 100 may track the deployment of firefighters to a forest fire. Since vehicles are not able to navigate many wooded areas, people must often respond to forest fires. Thus, the asset tracking system 100 may track these people. Other organizations may track people as assets 102 including the military tracking soldiers, companies tracking salesman, or mining companies tracking miners. One skilled in the art will recognize other situations where an organization may track people as an asset 102.

[0020]   Further embodiments may track other assets 102. Some items that may be considered assets 102 include, but are not limited to, shipping containers, aircraft (airplanes, helicopters, etc.), watercraft (boats, jet skis, etc.), train cars, or goods inventory. Practically anything an organization wants to track can be an asset 102 in an asset tracking system 100. One skilled in the art will recognize other items that may be considered assets 102.

[0021]   To communicate between the asset 102 and the asset server 116, the asset tracking system 100 may employ one or more communication networks. The communication networks may include, but are not limited to, wireless or packet-switched networks 104 (hereinafter referred to as networks, wireless networks, or packet-switched networks), radio networks, satellite communication networks, cellular networks, internets, LANs, WANs, or wireless LANs. The embodiment shown uses antennas to depict the networks 104. While a wireless network 104 is one network 104 that can be used in the asset tracking system 100, the present invention is not limited to that embodiment. Rather, the asset tracking system 100 can employ any type of communication network. With regards to the wireless network 104, the typical wireless network 104 can be a type of cellular network. A cellular network may include, but is not limited to, a PCS, CDMA, TDMA, FDMA, GSM, or other cellular system.

[0022]   In other embodiments, the wireless network **104** may include a system that utilizes an

IEEE 802.11 standard. These 802.11 systems can often be found in buildings and can operate as

wireless LANs. Other wireless systems like Bluetooth® or other wireless protocol may also be

used by the present invention.

[0023]   Private networks may also be included in the asset tracking system **100**. The private

network is a non-public system used exclusively by the operator organization employing the

asset tracking system **100**. These private networks can include, but are not limited to, radio

systems, dedicated cellular systems or services, leased fiber optic systems, or satellite

transmission systems.

[0024]   In some embodiments, the communications pathway may include an intermediate

system **110**. An asset **102** may transmit a signal to a wireless or other network which sends the

data to an intermediate system **110**. That intermediate system **110** can relay the information to

the asset server **116**. These intermediate systems **110** may include, but are not limited to, other

networks, WANs, LANs, or separate computers.

[0025]   The asset tracking system **100** may also include an internet connection **114**. The

internet connection simply means the data is transported over an internet, such as the World

Wide Web. Not all communications may go over the internet **114**. Rather, some of the

communications pathways may be direct connections from the networks **104** to the asset server

116. For instance, some of the networks **104** may be connected to the asset server **116** by a

dedicated T1 line. Other connections are possible. The internet **114** and these direct connections

are well known in the art and will not be explained further.

[0026]   The asset tracking system **100** will likely include an asset server **116**, sometimes

referred to as a mobile asset server. The mobile asset server **116** can function as the central

processor in the asset tracking system **100**. This server can collect, route, store, and process the outgoing and incoming data. The asset server **116** is explained in more detail below.

[0027] An embodiment of the asset tracking system **100** may include one or more operators **122**. The operators **122** may include other systems that further process and use the data from the asset tracking system **100**. For instance, these operators **122** may be the actual GIS systems at the user's location that use the asset location data. These systems may include any type of GIS or other system capable of providing a user with information about the assets **102**. GIS systems are well known in the art and will not be explained further. Operators **122** may also provide information into the asset tracking system **100**. An example of an operator would be the 911 dispatch center for the fire department or the police department that uses an asset tracking system. One skilled in the art will recognize the different systems or processes that may use the asset data.

[0028] In some embodiments, an operator system **122** may be connected to the asset server **116**. The operator systems **122** may include, but are not limited to, workstations, mainframes, or server-based system. In the embodiment shown, the operator system **122** is connected to the asset server **116** by the internet. However, any communication connection may be employed including, but not limited to, LANs, WANS, or wireless LANs. The protocol for this connection may be TCP/IP. One skilled in the art will recognize other protocols that may be used. Also, as explained earlier the data sent to the operator system **122** may be in an API format. This format ensures data is sent and received in the same arrangement every transmission. Thus, any configuration mismatches between the operator system **122** and the assets **102** are eliminated.

[0029] The operator systems **122** may also include the system to receive information from the customer **124**. Thus, the operator system **122** may employ a GIS system that uses the position

data provided by the asset tracking system **100**. In addition, the operator system **122** may input information into the asset tracking system **100** for use by the asset **102**. For instance, the operator system **122** may send location information about a customer **124** to assets **102** that need to respond to the location. Thus, the operator system **122** can receive and input all information needed to geocode a location. Also, the operator system **122** can operate the software to ensure the proper geocoding of locations.

[0030] The various systems in the asset tracking system **100** may be coupled together in any arrangement. One type of coupling may be communicatively coupling where the asset tracking system **100** may communicate between the different components. This communicative coupling may include, but is not limited to, a wireless interface, a hard-wired interface, an infrared interface, or an ultraviolet interface. Communicatively coupling, as used hereinafter in the description, carries the same meaning.

Mobile Device

[0031] Each asset **102** tracked by the asset tracking system **100** includes a type of mobile device **205**. **FIG. 2** shows a block diagram of an embodiment of the mobile device **205**. A mobile device **205** includes at least a communication device **210** and a position finder **220**. Other components in the mobile device **205** may include, but are not limited to, a processor **215**, a sensor array **240**, a memory **255**, a man/machine interface **250**, and a display device **245**.

[0032] The communication device **210** includes any device that can send or receive data from a communication network **104**. Devices may include, but are not limited to, radio transmitters and receivers, satellite transceivers, circuit-switched cellular units, internet routers, or similar devices. A common wireless transceiver **210** may be a cellular modem. The present invention focuses on assets **102** using cellular devices, such as CDPD modems. These cellular devices

may include any type of analog or digital cellular device. The cellular device may be capable of text messaging or other cellular functions. Cellular modems and their equivalents are well known in the art and will not be explained further. While cellular devices are used to describe the invention, the invention is not limited to that one embodiment.

[0033] The mobile device 205 in an asset tracking system 100 should also include a position finder 220. Without a position finder 220, the asset tracking system 100 would be unable to determine the position of the asset 102. Thus, these devices are inherently needed in a mobile device 205 in an asset tracking system 100. However, if the present invention is not part of an asset tracking system 100, the position finder 220 may not be needed. A position finder 220 may be a LORAN 230 or local positioning system. These local positioning systems may use signals from local, land-based systems to determine the position of the asset 102. LORAN systems 230 and their equivalents are well known in the art and will not be explained further. Another position finder 220 may be a system that determines the distance from several cellular towers and can provide a position of the vehicle 102 using the determined distances. This type of system and its equivalents are represented by the cellular tower distance finder 235.

[0034] In a preferred embodiment, the positional finder 220 would be a GPS receiver 225. The GPS receiver 225 can receive signals from one or more GPS satellites. A typical GPS receiver 225 decodes and analyzes the pseudo-noise signal from the GPS satellites. The GPS receiver 225 uses the signals to determine a coordinate-based position on the surface of the earth. GPS receivers 225 are well known in the art and will not be explained further. · A mobile device 205 can use one or a combination of position finders 220.

[0035] Another component in the mobile device 205 may be a processor 215. The processor 215 may be a commercially-purchased microprocessor or microcontroller. As an example, the

processor **215** may be from the Intel Pentium™ family, the Motorola PowerPC™ family, or similar type of processor. The processor **215** may also be modeled as a set of logic gates in a specially-designed ASIC or FPGA. For instance, the processor **215** could be modeled in an Altera APEX™ device. Processors **215** are well known in the art and will not be described further. The processor may execute the software for a mobile GIS system.

[0036] In some embodiments, a set of sensors **240** can be placed on the asset **102**. The sensors **240** form the sensor array **240**. Hereinafter, the sensors **240** and the sensor array **240** will be explained as interchangeable terms. However, it should be noted that one or more sensors **240** make the sensor array **240**. The sensors **240** can measure different systems or characteristics of the asset **102**. The sensors **240** may be piezoelectric devices, electromechanical devices, or other devices that can provide telemetry.

[0037] In one embodiment, one of the assets **102** may be a vehicle. The sensors **240** can measure parts of the vehicle. For instance, the sensors **240** may measure the pressure in the tires, whether the airbag has been deployed, the amount of fuel in the gas tank, the speed of the vehicle, the current odometer reading, or the achieved miles per gallon. If the vehicle were a snow plow, the sensors **240** may measure whether a plow is up or down. In a fire truck, the sensor array **240** may measure whether a water pump is operating or not, the water pressure, or the number of hoses being used. Sensors **240** on a police car may measure whether the sirens are one or off, whether a shotgun has been taken from a gun rack, or whether a person is in custody in the backseat.

[0038] In another embodiment, the asset **102** is a person. With a person, the sensors **240** may measure different biological functions. For instance, the sensors **240** may measure the heartbeat, the blood pressure, the blood sugar level, the respiration rate, or the body temperature. Any

biotelemetry capable of being measured can be monitored by the sensor array **240**. Depending on the asset **102**, other telemetry may be gathered by the sensors **240**. One skilled in the art will recognize other data that may be obtained from the sensors **240**.

[0039] The telemetry can include discrete telemetry, analog telemetry, or digital telemetry. Discrete telemetry is usually a measurement of a binary function. For instance, a police cars lights are either on or off. Discrete telemetry is normally represented by a single bit with a "1" representing the first state and a "0" representing the second state. Analog telemetry is a digital representation of an analog measurement. For instance, the body temperature of a person may include numerous data points, for instance, 98.7°, 99.2°, or 101.2°. The telemetry would use a plurality of bits to represent what the temperature is at that moment. Finally, digital telemetry is normally a value of some electronic component. For instance, a reading from a digital speedometer may be represented by digital telemetry.

[0040] In some embodiments, the mobile device **205** may include one or more of a display device **245**, a man/machine interface **250**, and a memory **255**. The display device **245** may be any type of electronic display. Examples may include CRTs, plasma screens, or liquid crystal displays. In one embodiment, the display device **245** can provide a graphical information system (GIS) map. As part of the GIS information, the display device **245** can show streets, vehicles, locations, or other data. In some embodiments, the display device **245** may display satellite imagery or other photographs of locations of interest. The GIS map may be capable of zoom and pan functions. These GIS maps may be in numerous formats including, but not limited to, ESRI shape files. One skilled in the art will recognize other information that the display device **245** may show. Display devices **245** are well known in the art and will not be described further.

[0041] A man/machine interface 250 is any device or system that allows a person to interact with the mobile device 205. An example of one man/machine interface 250 would be a keyboard. The man/machine interface 250 may also be a touch-screen. As in this embodiment, the display device 245 and man/machine interface 250 may be integrated into a single device. Other embodiments may also use a microphone and speaker. A voice recognition system may employ the microphone to allow interaction between the user and the mobile device 205. One skilled in the art will recognize other devices that can function as the man/machine interface 250. Such man/machine interfaces 250 are well known in the art and will not be explained further.

[0042] Another component may be a memory 255. The memory 255 may provide a place to store the operating system executed by the processor. However, the processor may have internal memory 255 to store the operating system. In other embodiments, the memory 255 may store information for use by the asset 102. This information may include GIS data. For instance, the memory 255 may store maps and route information. The memory 255 may include, but is not limited to, any optical, electromagnetic, or electrical memory device. These devices may include, but are not limited to, RAM, ROM, hard drives, optical discs, tapes, or discs. Memory devices 255 are well known in the art and will not be explained further.

[0043] In one embodiment, the processor 215, the display device 245, the man/machine interface 250, and the memory 255 are all included in a computer 260. This computer 260 may be a laptop computer. The computer 260 can perform all the functions of the other devices. In a further embodiment, the computer 260 can incorporate all the components of the mobile device 205, like the position finder and the wireless transceiver. Essentially, the computer 260 becomes the mobile device 205. Computers 260 are well known in the art and will not be explained further.

Asset Server

[0044] As explained earlier, the asset tracking system 100 will usually include an asset server 116. Some systems may not include the asset server 116. Rather, the operators 122 receive the information from the mobile devices 205 directly over the internet 114. The asset server 116 can function as the central device that processes and communicates with the mobile devices 205 and the operators 122. Many embodiments of the asset server 116 exist. One embodiment is shown in FIG. 3. The asset server 116 may include one or more parsers 330 and a message switch 335. Other components may also include, but are not limited to, an internet router 325 and a database 340.

[0045] The embodiment shown in FIG. 3 can be used with a wireless network 104. As explained earlier other communication connections may be made to the asset server 116. The asset server 116 includes those embodiments that need to use those other communications connections. More discussion will be given to some alternate embodiments below. In the embodiment shown, the mobile device 205 sends signals to a wireless network 104. The signals are sent onto the internet by a router 310. Those signals may then be received at the asset server 116. Sending signals out of the asset server 116 operates in the reverse order. While FIG.3 shows one specific embodiment, the invention is not limited to that one embodiment.

[0046] One device likely part of the asset server 116 is the message switch 335. Essentially, a message switch 335 functions as a data router or a data relay. Incoming data can have an association with a certain system. For instance, data from a fire truck asset 102 has an association with the fire department asset tracking system 100. The message switch 335 assigns an address to the fire truck data according to the association and sends that data to the fire department. The process is similar when data is sent to a mobile asset 102. The fire department

sends a location to which a fire truck must respond. The message switch **335** associates the data with one or more fire trucks and sends the message to those assets **102**. Similar associations are given to other assets **102** and there tracking systems. Using these associations, the message switch **335** can receive data from a multitude of sources and send it to the appropriate recipients. For instance, fire system messages go to fire department assets **102**, police system messages go to police department assets **102**, and public works system messages go to public works assets **102**. A message switch **335** can include any hardware device or software program that can effectively route the messages. An example of a message switch **335** would be the Nortel Networks Alteon Application Switch. Message switches **335** are known in the art and will not be explained further.

[0047] In one embodiment, the message switch **335** provides data to operator systems **122** in an application program interface (API). The API allows operators **122** or external software to use the data obtained from the various mobile devices **205**. In other words, the message switch **335** puts the data in a standard format for easy use by other programs. Connections with these outside systems **122** may include any internet **114** or intranet connections. In the embodiment shown, the message switch **335** sends data to the operators **122** via the internet. The message switch **335** sends the message to the internet router **325** that transmits the data to the operator system **122**. In other embodiments, the connection between the message switch **335** and the operator system **122** may include, but is not limited to, wireless LANs, WANs, or other systems using TCP/IP protocol.

[0048] As described earlier, the message switch **335** may manage multiple assets tracking systems **100**. In essence, the message switch **335** can provide the data routing capability for a plurality of asset tracking systems **100**. Thus, the message switch **335** may concurrently receive,

process, and provide data from a police asset tracking system **100**, a fire asset tracking system **100**, a snow plow asset tracking system **100**, and other asset tracking systems **100**. Thus, one message switch **335** can support all possible asset tracking systems **100**.

[0049]   Another component in the asset server **116** is a parser **330**. The parser **330** functions as a communications interface between the mobile device **205**, the network **104**, and the message switch **335**. A parser **330** is a communication transceiver, which may be embodied in a hardware device, a software program, or a combination of both. Each parser **330** can connect and communicate to or with a different system or with systems using different protocols. For instance, one parser **330** may communicate with mobile devices **205** using a cellular system. This cellular system may be using a CDPD protocol. Another parser **330** may communicate to mobile devices **205** using GSM cellular systems. Yet another parser **330** may communicate with mobile device **205** using a private radio network **104**. Another parser **330** may communicate through a satellite link using an MPEG protocol. The parsers **330** may use any type of communication system or protocol. There is one parser **330** for each type of system or each type of protocol.

[0050]   The parsers **330** can receive all the incoming data in different formats. The parser **330** can translate this data from the specific protocols into a standard format. Thus, the parser **330** may also be a translation device. The parser **330** can be a hardware device or software for changing data in one format into another format. While the embodiment shown only has one parser **330**, there may be a plurality of parsers **330**. One parser **330** can be created for each communication network **104**. In this way, the asset server **116** may only need one message switch **335** for all the different types of networks **104** that may be used. Thus, adding new mobile devices **205** using new networks **104** only requires the addition of more parsers **330**.

Such a system provides maximum flexibility because a user does not need to create a new message switch **335** every time a new system is added.

[0051] Data sent to the message switch **335** is in a standard format. In the embodiment shown, the standard format would be TCP/IP. However, one skilled in the art will recognize other protocols that may be used for the standard format. Also the standard format may also describe the arrangement of the data. For instance, in a message, bits that represent the asset identifier may precede the bits that represent the asset telemetry or the asset position. One skilled in the art will recognize the different arrangements of the data that are possible. A parser **330** may also rearrange the formats and protocols of out-going messages. Thus, the parser **330** can take data in the standard format and translate it into the protocol and format specific to the mobile device **205**, outside device, or outside system.

[0052] The asset server **116** may also include a database **340**. A database **340** is a storage system for asset tracking data. The database **340** may be any type of storage device including, but not limited to, electromagnetic, magnetic, optical, or electrical. An example would be the StorageTek PowderHorn® 9310 System. Other examples may include RAID systems or a storage disc system like one from the Iomega Zip disc family.

[0053] Another component may be an internet router **325**. An internet router **325** may be any transceiver that can send and receive messages over the internet. The internet router **325** can help the message switch **335** send information to third party systems. The internet router **325** may also receive data from a mobile device **205** and send it to the parser **330**. Internet routers **325** are well known in the art and will not be explained further.

[0054] In some embodiments, the asset server **116** may be a single computer or several connected computers. For instance, the asset server **116** may include several servers connected

as a network **104**. This type of distributed computing may also use other components such as mainframes or workstations. In one embodiment, all the connected devices transfer data using TCP/IP protocol. Data goes through the message switch **335**. At the message switch **335** the data can be sent to another asset server **116**. In another embodiment, two asset servers **116** concurrently receive the data. One of the asset servers **116** can function as a back-up.

[0055] Using IP addresses, the asset tracking system **100** may have several separate systems running in parallel. For instance, the asset server **116** may have a back-up system. The back-up system need not be collocated with the primary asset server **116**. Rather, the back-up system can be located in another building, another city, another state, or another country. Any data going to the primary asset server **116** may be copied and retransmitted to the back-up station. The back-up station may have the same IP address and receive duplicate messages from the transmitting devices. A back-up station may have duplicate systems or a different configuration from the primary asset server **116**. One skilled in the art will recognize that there are other architectures and other connections are possible for the asset tracking system **100**.

Geocoding

[0056] Geocoding is a method **400** of attributing a location in a GIS environment. In one embodiment, latitude and longitude coordinates can be assigned to the location. The location can then be displayed on a GIS display. To geocode, other information may be obtained and used to create the latitude and longitude coordinates. For instance, the latitude and longitude of street intersections, for addresses, for the centers of zip code areas, the centers of area coded areas, or other information may already be known. Since latitudes and longitudes can be created for already known information, new unknown locations may be determined using the known information.

[0057] A geocode may be created from different location information or location characteristics. These characteristics may include, but are not limited to, addresses, a set of cross streets or intersections, ZIP codes, telephone area codes, latitude and longitude, a phone number, or other information. To create the geocode, an individual provides an item of information, such as their address. An operator 122 or user can enter the address into the GIS system. The GIS system may be incorporated in the operator system 122, in the asset server 116, or in a separate system (not shown) that can be connected to the operator system 122 or the asset server 116. Hereinafter, the invention will be described as the GIS system being a part of the operator system 122. However, this description is not meant to limit the invention to that one embodiment.

[0058] The GIS system can find an address segment with matching information. An address segment is a representation of a street that has a start address number on one side and an end address on the other. For instance, 50 Main Street would be half way in the 0-100 Main Street address segment. Latitude and longitude coordinates can be known for the start address and the end address, 0 Main Street and 100 Main Street, respectively. Thus, the GIS system can estimate the latitude and longitude coordinates for the address. To estimate the coordinates, the GIS system determines that the address is approximately half-way between the start address and end address. Then, the GIS system can equate this position with a latitude and longitude coordinate that would be approximately half-way on an arc between the start address and the end address.

[0059] Finding Geocodes for other information may follow similar procedures. For instance, a latitude and longitude can be known for a 9 digit ZIP code, which represents about nine houses. In addition, latitude and longitude may be known for a 7-digit or 5-digit ZIP code. Latitudes and longitudes can be known for an area code or cross streets at or near the location. Although this information is not as accurate as the address, this information provides known information from

which coordinates may be interpolated. This geocoding information is available from many sources and is well known in the art. Thus, geocoding information will not be explained further. One skilled in the art will recognize other information that may be used for geocoding.

Method for Proper Geocoding

[0060] The present invention provides for methods to ensure proper geocoding. Three embodiments of the method for ensuring proper geocoding are shown in **FIG. 4A, FIG. 4B**, and **FIG. 4C**. In an asset tracking system **100**, geocoding is used to dispatch assets **102** to customer **124**. For instance, a police agency may use geocoding to establish a location of an emergency call. The asset tracking system **100** can automatically dispatch the police car to the location once the location is geocoded. In other words, geocoded locations can be input and sent electronically to the mobile device **205** in the field. The mobile device **205** may display the geocoded location, which allows the asset **102** to respond to the information shown on the display **245**.

[0061] Although the geocoding system can often provide accurate location coordinates, sometimes errant geocodes are created. These faulty geocodes may occur when an address is new and not in the geocoding information or when there are similar addresses in the town. If an errant geocode is input into the asset tracking system **100**, one or more assets **102** may be sent to the wrong location. To put this problem in specific focus, the following example is given. A fire truck may receive a wrong geocode and respond to the wrong geocoded location presented on the display device **245**. When the fire engine arrives at the location, there would be no emergency – no fire. Meanwhile, at the actual location across town, some citizen's house is burning down and the fire department is not responding. This situation can be avoided. The present invention overcomes these problems.

[0062]   In the invention, a customer **124** can call **402** the operator organization **122**. The customer **124** refers to any person or organization that may use or partake of an operator organization's service. The operator organization **122** providing the service uses an asset tracking system **100**. Customers **124** may include, but are not limited to, citizens needing help from the police or fire department, customers **124** needing help from a service center, or citizens needing help from public service employees. The operator organizations **122** providing service may include, but are not limited to, the police department, the fire department, public works department, a company providing a service to or an installation for the customer **124**. One skilled in the art will recognize other customers **124** and other operator organizations **122** that could provide services.

[0063]   In the asset tracking system **100**, the customer **124** provides characteristics about the location. The customer **124** may provide either the operator organization **122** or the asset server **116** information. If the customer **124** provides the information to the operator organization **122**, that operator organization **122** can input the information into the asset server **116** or determine the proper geocoding at the operator organization **122**. In **FIG. 5**, one embodiment of the input page **500** is shown for customer inputs into the asset tracking system **100**. An operator may enter these inputs, but a customer **124** may also enter the inputs on their own. For instance, the customer **124** may schedule a service call on the internet and use the input page **500** to give the information for the asset tracking system **100**.

[0064]   The diagram **500** shows that the customer **124** may provide for numerous different inputs. These inputs may include, but are not limited to, an address **502**, a city **504**, a zip code **506**, a county **508**, a state **510**, a phone number **512**, a coordinate location **516**, or a set of cross streets **514**. Other embodiments of the input page **500** are possible and included in the invention.

One or more of the several characteristics are entered into the GIS system. One characteristic given may be an address **404**. The customer **124** may give one other descriptor or characteristic **406**. In a preferred embodiment, the other characteristic is nearby cross-streets or the latitude and longitude coordinates of the location.

[0065]   A GIS system may decide to send a location to the assets **102** that was determined with only one piece of information. However, at least two inputs may be needed to verify the accuracy of the location in the GIS system. More than two items of information further increase the confidence in the position of the locations. Thus, the present invention provides accurate geocoding if the customer **124** provides more than one different characteristic for the location. However, even two characteristics may not be enough to ensure that the location is 100% accurate as geocoded.

The GIS Map

[0066]   The GIS system finds the latitude and longitude for the different characteristics provided and compares the two latitudes and longitudes **408**. The two or more coordinate positions can be shown on a GIS map. The GIS map may take many forms. **FIG. 6** provides a GIS map **600** in accordance with an embodiment of the present invention. In one embodiment, the maps **600** may be ESRI maps. In other embodiments, the maps **600** may be constructed in AutoCad or another GIS mapping system. The GIS map **600** gives a graphical representation of a location in the GIS system. In the map **600** shown, streets **602**, buildings **604**, waterways **606**, and other information may be shown.

[0067]   As part of the geocoding, the information provided by the customer **124** may be shown on the map **600**. For instance, the latitude and the longitude of the address given **608** may be displayed on the GIS map. If the address **608** is 133 Main Street, the GIS map **600** can display a

marker **608** a third of the way between 100 and 200 Main Street. The other information may also be shown. For instance, a marker may be placed on the map for the center of the area code **612A**, for the center of the zip code **610A**, or where the cross streets **622** are located. In other embodiments, the map **600** may shade the area covered by the zip code **610** or the area code **612**.

[0068] To determine if the location is accurate, either the user or the GIS system may determine if the markers **608, 622, 610,** or **612** identify the same location. In other words, the determination verifies whether the markers or geocodes are spatially near or within physical proximity **410**. Physical proximity may be a set amount of distance apart. For instance, the user may determine if the address marker **608** is in the area represented by the area code **612** given. In other embodiments, the user can check that the cross streets **622** are located near the address **608**. For instance, the cross streets **622** may be one or two blocks from the given address **608**.

[0069] In other embodiments, the GIS system automatically checks the information. As an example, characteristics may be input into the GIS system either by an operator or automatically by some other system. The GIS system may determine if the characteristic, like the address **608**, is located in the phone area code **612** or the zip code area **610**. The GIS system may also determine if the two or more characteristics of the location are within a second or minute of latitude or longitude. In other embodiments, the GIS system may determine if two or more characteristics are within a street block of each other, or whether those characteristics are within a set distance measured in miles or fractions of a mile, like 1.33 miles. If the items of information do not identify the same location **412**, the system can determine if more descriptors are available **416** or needed. This determination may involve the system **122** prompting the user to ask the customer **124** for more information. The GIS system can receive new information from the customer **124**. In other embodiments, the operator system **122** may be able to extract

other information from electronic sources communicatively coupled to the GIS system, such as a caller identification system. If more descriptors are available **418**, those descriptors may be used to compliment the other already known descriptors in finding the location. If there are not other descriptors **420**, the user may decide to respond **424** to the customer **124** without the use of the GIS system. In other words, the user may verbally dispatch an asset **102** without forwarding the various longitudes and latitudes of the locations to the asset's mobile device **205**.

[0070] Another example of a method **400B** for proper geocoding is shown in **FIG. 4B**. In this embodiment, the operator organization **122** receives **426** a phone call from the customer **124**. During the phone call, the customer **124** provides information **428**. This information may include the address **502**, the nearest intersection **514**, or the coordinates **516** of a place **608** where the operator organization **122** must respond. These items of information may form a first, second, and third characteristic. In this embodiment, only one or more of these three items of information are provided. Also, the customer **124** may provide only one, only two, or all three of the items of information.

[0071] Two different steps can be taken if the customer **124** provides only one item of information **430**. If only one item of information is collected **432** from the customer **124**, the operator organization **122** may determine if another item can be collected **434**. If the determination is that another item of information is available **436** and can be provided, the operator organization **122** may ask **428** for that additional piece of information. However, if that additional piece of information is not available **438**, the asset tracking system **100** may plot **450** the GIS position for the item of information that was provided. This plotted information may then be forwarded to an asset **102** to respond.

[0072] If two or more items of information are provided **440**, then the asset tracking system **100** may determine if the two items of information are within physical proximity **442**. Determining if the two or three items of information are within physical proximity may occur in the same manner as described previously. However, in this embodiment, if the two items of information are not within physical proximity **446**, an error report may be shown **448** to the operator organization **122**. In analyzing physical proximity for three items of information, the asset tracking system **100** may determine if, for example, the coordinates and the address **502** are within physical proximity and the coordinates and the intersection **514** are within physical proximity. In other embodiments, a third determination may include if the address **502** and the intersection **514** are within physical proximity. The GIS code for the place **608** will be plotted. The GIS system can allow **450** this same location or geocode to be sent to an asset if the above determinations show the characteristics are spatially near **444**. If one or more of the determinations fail to show physical proximity **446**, an error report may be shown to the operator organization **122**. An asset **102** can respond **452** or be sent to the same location represent by the geocode that is plotted and spooled to the asset **102**.

[0073] In another embodiment **400C**, the GIS system would set a threshold **454** for a level of confidence in any geocoded location. For instance, the threshold may be 80%. The threshold may vary depending on the circumstances. The threshold may be set by the operator or some other outside entity or system.

[0074] The GIS system may only need three or fewer items of information to ensure proper geocoding. These three items of information may be the address, the latitude and longitude, or a set of cross streets. The customer **124** may call the operator of the GIS system **456** and provide one or more of these characteristics **458**. Upon receiving an item of information, the GIS system

may geocode the location and generate a level of confidence in the accuracy of the geocode. The level of confidence reflects some amount of accuracy that the geocoded location is the customer's actual location. The amount of confidence may vary depending on the item of information geocoded. For instance, the level of accuracy for the latitude and longitude would be higher than for the cross streets. This difference reflects that cross streets may be several blocks away while the latitude and longitude may characterize the customer's exact location. The address would likely have a level of confidence between the cross streets and the latitude and longitude.

[0075] Before allowing the geocoded location, the GIS system would determine **460** if the level of confidence is greater than the threshold. A piece of information that provides a level of confidence above the threshold **464**, would allow **468** the GIS system to spool the geocoded location to the assets **102**. For instance, if the customer **124** gives the GIS system a latitude and longitude, the level of accuracy may be 85%. Thus, no other information would be needed to geocode the location. In this situation, the GIS system may allow the geocode to be sent to the assets **102** without verifying the information with other characteristics.

[0076] However, if the customer **124** provides a characteristic with a level of confidence below the threshold **462**, the GIS system may determine if more descriptors are available **466**. For example, for the address, the level of confidence may only be 75%. Now, the GIS system must gather another item of information to raise the level of confidence. If more descriptors are available **472**, then the customer **124** may provide **458** another descriptor. For example, the operator may ask the customer **124** if the address is near a certain set of cross streets. If the customer **124** replies in the affirmative, the operator may enter those cross-streets into the GIS system. A new level of confidence is generated or determined for the two or more

characteristics. The added piece of information may raise the level of confidence to 90%. Thus, the geocoded location is accurate and will be sent **468** to the assets **102** in the field. If no other descriptors or characteristics are available **470**, then the operator may allow an asset **102** to respond **474** to the customer **124** anyway.

[0077] The increased confidence from the added characteristics may be created because the two or more characteristics are spatially near. In essence, the level of confidence increases in a geocode if one or more characteristics are in physical proximity to a first characteristic. For instance, if the location of the cross streets is within a mile of the address then the level of confidence may increase. The level of confidence may increase or decrease depending on the type of characteristic and the distance between characteristics. In one embodiment, a cross streets one city block from the address may yield a 90% level of confidence while a cross streets within a mile of the address may yield an 80% level of confidence. In another embodiment, a latitude and longitude within a block of the address may yield a 95% level of confidence while a cross streets within a block of the address may only yield a 90% level of confidence. One skilled in the art will recognize other methods to determine or generate a level of confidence.

[0078] In some situations, the GIS system may only use two pieces of information to ensure proper geocoding even if three characteristics are available. One skilled in the art will recognize the different combinations that may be made to reach the level of confidence. In addition, one skilled in the art will recognize that other items of information may make up the set of information required or used.

[0079] If the system or user believes that two or more pieces of information are identifying the same place **414**, the system or user can allow the geocode to be sent or spool to the mobile devices **205**. To forward the information, the asset server **116** or operator system **122** may

provide a prompt to the user that the information is accurate. This prompt can be, but is not limited to, a pop-up window, a sound, a flashing light, or a text message. The user can accept the location and instruct the GIS system to geocode the location for the mobile devices **122**. In other embodiments, the system may automatically accept and forward the geocode.

[0080] The asset server **116** can then send the geocode to the parsers **330** which will translate the message and transmit it over the network **114**. Upon reaching the network **114**, the message is transmitted to the mobile device **205**. The mobile device **205** can receive the message and translate it into a prompt for the asset **102**. This prompt may include, but is not limited to, a sound, a pop-up window, a flashing light, a text message, or a combination of the these. The wireless transceiver **210** receives the message and sends it to the processor **215**. At the processor **215**, the message is translated and sent to the display device **245**. The computer **260** can use the geocode and derive a best route to the location. In other embodiments, a best route is sent with the geocode. The asset **102** can respond **424** to the geocode.

Example of Geocoding

[0081] To further explain the present invention, an example is given hereinafter. A citizen in the town awakes to the fire alarm. After stirring to find that the kitchen is engulfed in flames, the citizen calls the fire department **122**. The 911 operator answers the emergency call. The citizen explains that their house is on fire. The 911 operator then asks for the citizen's address and enters it into the address field **502** of the input sheet. The address provided is 133 "Main" Street. The GIS system **122** has the capability to determine all variants of different words including "Main" or "Mane." Ironically, two locations with street names of "Main" **608** or "Mane" **620** are displayed on the GIS map **600**. The level of confidence that the correct address is geocoded is only 50%, which is below the 80% required level of confidence.

[0082] The fire department's GIS system 122 realizes that more information is required to determine which address (608 or 620) is correct. If the wrong address is used, the GIS system 122 may have fire engine 614 respond to address 620 instead of fire engine 616 respond to address 608. Such an error could result in the citizen's house burning down or one of citizen's family members dying in the fire. Thus, the GIS system 122 uses caller ID to obtain the citizen's area code and phone number and enters it into the phone number field 512. The area code area 612 covers both address (608 and 620). However, the center of the area code area 612A is closer to the "Main" address 608. Thus, the level of confidence that the "Main" address 608 is correct goes up to 55%. The GIS system 122 realizes that even more information is required.

[0083] The GIS system 122 now prompts the 911 operator for more information. The 911 operator asks for the citizen's zip code. The citizen provides the five digit zip code of "11011." In the input page 500, the 911 operator enters the zip code into the zip code field 506. The zip code provided covers the zip code area 610. Fortunately, only the "Main" address is in the zip code area 610. The level of confidence now reaches 90% that the 608 address is correct. This level of confidence exceeds the threshold. Thus, the GIS system 122 now identifies and marks the 133 Main address as the appropriate location to which to respond. Between the two fire engines 616 and 614, the fire department or GIS system decides that fire engine 616 should respond because that asset 616 is closer to the address 608.

[0084] The GIS system 122 sends the information to the asset server 116. The message switch 335 determines that the information is related to the fire department asset tracking system 100. Thus, the message switch 335 configures the message and marks it for transmission to fire engine 616. A parser translates and formats the message for the mobile device 205 in the fire engine 616. The parser 330 transmits the message over the internet 114 to a wireless network

104. The wireless network 104 relays the message to the mobile device 205. At the mobile device 205, the wireless transceiver 210 receives the message and sends it on to the processor 215. The processor 215 has the display device 245 display the location on a GIS map for the asset 616. The processor 215 generates a best route to the address 608 and displays the route on the display device 245. In this way, the correct fire engine 616 responded to the correct address 608. The citizen's house is saved and the loss of life averted.